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Enhancing Performance Under Stress by Information about its Expected Duration

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This research note discusses experiments in which four groups of subjects were given two stressful tasks; the Dynamometer test, and the Cold Pressor test. At the same time, the test subjects were given different information about the tests' duration. The information conditions were: no information, exact information, false long (with subsequent encouraging correction), and false short (with subsequent discouraging correction). Endurance was highest with the exact information condition, lowest in the no information condition, and the (OVER)

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20. Abstract (continued)

other two groups produced intermediate results. Timing of the maximal heart rate during the task was systematically related to information, and its role as a potential indicator of psychological "breakdown" was analyzed.

INTRODUCTION

There is hardly a more dramatic illustration of the power of information to affect human endurance than the "tour of duty" phenomenon. The success of this intervention, and its frequent usage as standard policy in many areas of conflict, is in major contrast to the paucity of research in this area. The fact that the underlying psychological mechanisms responsible for this effect were never systematically studied, is particularly surprising in view of the high cost-effectiveness of increasing endurance and performance level by information management. The main objective of the present research is to analyze this paradigm in a laboratory setting. This Annual Report deals with the first part of a coherent experimental program which aims to systematically explicate those features of information about the expected duration of a stressful task, that have the potential to enhance effective functioning.

In order to reduce the danger of psychologically detrimental information mismanagement, it is necessary to test the typical pitfalls and constraints of this paradigm, as well as its opportunities. A vital part of the experimental program contains, therefore, specific attempts to understand how certain types of information can lead to discouragement and reduced performance.

Background information

McGrath (1970), Appley & Trumbull (1967), and Breznitz & Goldberger (1982) point out that time may be one of the most important parameters of stressful situations, yet it has been one of the most neglected areas in stress research. In their most recent analysis of current knowledge in the area of psychological stress, Lazarus & Folkman (1984) discuss the role of, "temporal uncertainty" and "imminence" in affecting the stress reaction. It is of some interest to note, however, that both temporal uncertainty and imminence have been studied exclusively in relation to the onset of stress, never in relation to its termination. Thus, in spite of the fact that duration of stress is widely considered a major factor in dysfunction and disease, (most notably Selye, 1950, 1956), the impact of psychological signaling of duration remains largely untested territory.

Data from four different sources suggest, however, the potential importance of information concerning termination of a stressor. These sources consist of: research on anticipatory stress, research in the area of 'goal setting', studies using the 'cold pressor test' paradigm, and a specific pilot study, carried out by the principal

investigator, using soldiers on a difficult march. The findings most relevant to the design of this experimental program deserve special attention.

Anticipatory stress.

Information concerning the temporal aspects of threats plays a major role in determining stress levels during the anticipatory phase. Thus, information about the imminence of the anticipated danger, (or otherwise stressful event), determines both the intensity of the emotional reaction, as well as a host of cognitive and behavioral outcomes.

In situations that provide the person with full information about the onset of the danger, and he/she is objectively helpless, duration of anticipation increases the stress reaction. Breznitz (1967) uses the concept "incubation of threat" to describe this phenomenon which has been by now replicated in several studies (e.g.: Breznitz 1968; 1971; 1984; Nomikos, Opton, Averill, & Lazarus 1968; Folkins 1970; Mansueto, & Desiderato 1971). There is thus good reason to expect that information about the anticipated duration of the stress itself will have significant effects on stress level and performance.

Studies of 'warning systems' clearly indicate that the frequency and pacing of information can determine the exact function plotting fear levels over time (Breznitz, 1972; 1984). Depending on its serial position and timing, each warning signals differential levels of danger and/or safety. (See also the 'safety signal hypothesis' in attempting to explain preference for signalled as opposed to surprise stressor (Badia, Harsh, & Abbott, 1979; Weinberg & Levine 1980)). This suggests that in addition to telling people when the stress will be over, it might be important to control the frequency and timing of ongoing feedback.

Goal setting.

Within organizational and industrial psychology, there developed a body of evidence suggesting that by presenting a worker with a definitive goal it is possible to obtain increse in performance levels. This is of some relevance to our present analysis, in view of the fact duration of a task may, in principle, be considered a case in which the goal is to persist on a task for a given period of time. The basic argument is one of increased motivation, although other benefits of goal setting have been mentioned. In a recent review of the evidence, Locke (1981), who is a leading contributor and theoretician in this field, reaches the following conclusions:

"Results from a review of laboratory and field studies on the effects of goal setting on performance show that in 90% of the studies, specific and challenging goals led to

higher performance than easy goals, "do your best" goals, or no goals. Goals affect performance by directing attention, mobilizing effort, increasing persistence, and motivating task performance when the goals are specific and sufficiently challenging, subjects have sufficient ability, feedback is provided to show progress in relation to the goal, rewards such as money are given for goal attainment, the experimenter or manager is supportive, and assigned goals are accepted by the individual." (p. 125).

Knowledge of results is a key factor in any potential benefit of goal setting (e.g.: Erez 1977; Becker 1978). This again points to the potential importance of the various parameters of informational feedback concerning duration of a stressful task. Such information provides answers to questions like: "How far to the goal?" or "How much longer?"

Cold pressor test.

The cold pressor test (CPT) is a frequently used experimental paradigm of stress research. It provides an opportunity to study reactions to pain within a controlled setting. Typically, the subject is required to immerse one hand in water mixed with ice, maintained at 1-2 degrees centigrade. With the possible exception of patients with advanced coronary heart disease, this procedure, although very painful, is totally harmless. Since the most frequently tested outcome using the CPT is duration of pain tolerance, it is particularly well suited for the purposes of the present research program.

It is interesting to note, that in spite of virtually hundreds of experiments using this method, only one attempted recently to manipulate information about duration of the pain (Stevenson, Kanfer, & Higgins 1984). The rest are predominantly interested in a host of mediating factors, coping strategies, and individual differences variables, that may affect tolerance levels.

Autonomic measures, particularly heart-rate and skin conductance were demonstrated to be sensitive to the CPT manipulation, but their exact relationship to tolerance levels is not yet clearly established (Dowling 1983; Shapiro 1983).

It is of some interest to note that the only study that focused on manipulation of information concerning the length of the CPT task (Stevenson, Kanfer, & Higgins 1984) was carried out from the perspective of the 'goal setting' tradition. The results indicated that the specification of the goal increased the mean tolerance times. This is what should happen if our reasoning is valid. Unfortunately, the above experiment did not go beyond the simplest manipulation

of goal/no goal, and thus in spite of its obvious importance, our main task remains undone.

The above analysis of background information pointed towards some of the particularly promising variables that this research program attempts to investigate.

RESEARCH QUESTIONS AND HYPOTHESES

The main thrust of the present research is the elucidation of the ways information about duration of a stressful task can enhance performance. The discovery of the main parameters that optimize information management can provided decision makers with general policy considerations, as well as particular tactical guidelines in a variety of military settings.

(a) Information at start.

The simplest independent variable is information about the duration of a stressful task, that is available at its onset. Our hypothesis is that the absence of such information reduces performance.

(b) Encouraging vs. discouraging information at start.

Although we hypothesize that most types of information are better than none, their differential effects depend on the objective implied duration. Thus, if a particular stressful task is expected to be relatively short, this implies 'encouraging information' at start. By the same token, the duration specified at start may be perceived as longer than the person can reasonably expect to cope with effectively. This implies 'discouraging information' at start. We hypothesize that 'encouraging information' at start, as long as it is credible, enhances performance. Credible 'discouraging information' at start reduces performance. Furthermore, deleterious effects of stress on performance are expected to appear earlier in the 'discouraging information' situation.

(c) Information en route.

Information en route to the goal can be given continuously, in a pattern of discrete signals, or not given at all. We hypothesize that the frequency and pacing of this type of information will have significant effects on task performance. In addition, it is expected to amplify the effects of information at start. Thus, for instance, we predict that feedback along the way may further enhance task performance if the information at start was encouraging, and lead to significantly greater performance deficit if it was discouraging.

(d) Disconfirmation en route.

During task performance new information, different from the one given at start, can be presented. This is often the case in real life situations, since tasks may change during their performance. There can, of course, be 'encouraging disconfirmation', i.e. learning that the new duration is shorter than initially expected, or 'discouraging disconfirmation', implying the opposite. We hypothesize dramatic changes in task performance as a result of disconfirming information. This effect will depend on the timing of the new information in relation to passed time and to remaining time. In other words:

1. The longer the duration spent with the initial information, the less significant the impact of the new information.
2. The longer the remaining duration following disconfirmation, the more significant the impact of the new information.

The present research program may enable us to discover typical "breakdown points", some of which might be information induced. The findings should help us to answer a host of related questions such as: How and when best to encourage individuals? When to remind them of the task yet ahead and when to divert their attention? What are some of the important costs of a policy of limited information? When, if ever, can false information have such an overwhelming advantage as to be pragmatically justified?

METHOD

The Stressors.

The above analysis suggests the usefulness of the cold pressor test (CPT) as the basic stressor to be used in this research program. There is extensive evidence that pain tolerance is sufficiently sensitive to experimental interventions. At the same time, in order to increase both the generalizability and the applicability of our results, it is important to use other stressors as well. The obvious relevance of physical exertion to a variety of military tasks, made the task of pressing a dynamometer an appealing candidate. All subjects were thus exposed to two stressors: the dynamometer test (DT) and the (CPT), in that order.

Independent variables.

The target for the ET was set at 70 seconds, at 60% of subject's maximal press, with the dominant hand. The target for the CPT was set at 4 minutes, with the non-dominant hand. Using a between subjects design, 80 subjects were randomly divided into four different conditions:

In the no information condition, subjects were asked to perform both tasks until the experimenter tells them that the test was over. There was no clock in the subjects' room, and their watches were removed prior to the beginning of the DT.

In the exact information condition, subjects were asked to perform the DT for 70 seconds, and subsequently to keep their hand in the ice cold water for 4 minutes. A digital clock in front of their eyes precisely indicated the passage of time.

In the false long condition, subjects were asked to press the dynamometer for 120 seconds, and after 30 seconds heard that the duration was shortened to 70 seconds. Next, they were asked to endure the CPT for 5 minutess. However, after 2:45 they were told that the duration was only 4 rather than 5 minutes.

Lastly, in the false short condition, subjects were asked to press the dynamometer for 45 seconds. After 30 seconds this was prolonged to 70 seconds. In the second task they were asked to endure the pain for 3 minutes, but after 2:45 this was prolonged to 4 minutes.

Table 1 describes the experimental design according to tasks and information condition.

Insert Table 1 about here

Dependent variables.

The present experiment focused primarily on the behavioral measures of endurance. Thus the frequency of subjects carrying out the task to its successful completion, as well as the exact time of 'giving up' was measured. Heart-rate was measured continuously throughout the entire experimental sequence. Subjective reports of stress, as well as responses to direct questions pertaining to the various features of the experiment, were secured shortly after termination of the CPT.

Individual differences variables.

At this stage of our knowledge, the selection of potential important individual differences variables, is very much a search in the dark. Literature search concerning research with personality variables using the CPT procedure, did not discover any major reliable effects. Considering the specific focus of the present study, some variables appeared to be intuitively relevant. Thus, it was thought of interest to obtain measures of tendency towards discouragement (Beck's Hopelessness Scale), and of Locus of Control (Rotter).

As part of the Principal Investigator's interest in the role that denial of stress plays in effective functioning under stress (Breznitz, 1982), we have developed a tentative instrument to measure the tendency to deny the personal relevance of a variety of threats. It consists of a set of stated statistical probabilities to be harmed in a variety of situations. Subjects are asked to give the subjective probability that they will be harmed in those situations. The comparison of the subjective probabilities with the given, objective probabilities, allows the calculation of a 'denial score' for each subject. Since this study attempts to evaluate the value of veridical information, as opposed to falsely encouraging one, it was thought worthwhile to include the denial instrument as well. APPENDIX A presents the DENIAL measure.

Subjects and Procedure.

All subjects project were male students at the University of Haifa. They were recruited from the entire body of students on a voluntary basis. A fee of IS20.00 (about $12.00) was offered for participation. All subjects were tested individually.

Protection of Subjects. Only subjects who were in perfect health could participate. At the onset, as well as after learning the purpose of the study, subjects were reminded of their privilege to terminate the experiment at any moment, without prejudicing their remuneration. Only after obtaining a signed informed consent did the experiment proper begin. (See Appendix D for the exact forms used).

CPT is one of the best researched stressors, and while obviously painful, does not produce any harm. The durations used in this study, as well as the water temperature (1-2 centigrades), are well within the range documented harmless.

Laboratory setup. Two experimenters were used for the testing of each subject. The laboratories consisted of two adjacent rooms with a one-way mirror between them. The lighting in the control room (hosting the experimenters and the instruments) was always weaker than in the subject room, allowing the observation of the subject without his awareness. Upon arrival, the subject was greeted by one of the experimenters, and seated in the subject room. After a series of questions concerning his health status, the subject was asked to give his signed consent to participate, and to agree not to discuss the details of the experiment with anybody outside the laboratory. He was then attached to the polygraph (Grass, 7D) in order to obtain continuous readings of heart-rate. The electrode consisted of a photoelectric cell (Type TTY) which was attached to the subject's right earlobe. This attachement was found less sensitive to artifacts related to minor movement, and at the same time allowed the free use of boths hands. Immediately

after finding the quality of the heart-rate reading satisfactory, the subject was given the 'Baseline Instructions'. In order to ensure reliability, all instructions were recorded in advance, using an FM audio recorder.

The 'Baseline Instructions' were the same for all subjects, irrespective of their subsequent experimental treatment: "For your participation in the experiment you will receive a basic sum of IS20.00. We are interested to read your lowest heart-rate, so please sit quietly for a few minutes, and try to relax as much as possible."

Next followed two minutes of 'baseline' recording, followed by the first task, i.e., pressing the dynamometer. This task presents two methodological difficulties: Firstly, it is unreasonable to expect subjects to keep the dynamometer pressed to the maximum for any significant duration. In fact, the maximal press can be maintained for a few seconds only. Secondly, it was important to reduce the effects of individual differences in muscular strength as much as possible. In order to resolve both problems, we asked each subject, using his dominant hand, to briefly press the dynamometer once to the maximum, and read his own score. The actual task then consisted in pressing the dynamometer again, and keeping it pressed above 60% of their own maximum. The dynamometer was connected to the polygraph, providing full information about subject's performance.

The DT instructions were: "When you will be told to start, press the handle in front of you once, as strongly as you can. Now!...Release".

And after five seconds, depending upon the experimental variation: "Don't do anything before the start signal. Now we shall test your ability to sustain a prolonged effort. You will be asked to press the handle in front of you as strongly as possible, and keep it pressed

until we tell you. (No Information)
for 70 seconds. (Exact Information)
for 120 seconds. (False Long)
for 45 seconds. (False Short)

If you could finish the task without releasing the handle below 60% of your short previous press, you will receive IS10.00 in addition to your basic remuneration. Take care, releasing the handle below 60% of your short press will be considered as termination of the task. The intensity of the press is continuously recorded, and you will be able to check our decision, if you so desire. Remember, your previous press was ... units, therefore 60% are ... units. START!"

After 30 seconds, subjects in the last two groups were given the correction: "Pay attention! The time was shortened from 120 to 70 seconds. (False Long)

prolonged from 45 to 70 seconds. (False Short)
All other conditions remain the same."

Following the termination of DT (either by the subject himself, or after 70 seconds), the 'Between Tasks Relaxation' Instructions, similar for all subjects, were given:

"The pressing task is now over. Relax and rest for a few minutes."

The 'Between Tasks Relaxation' period was of 2 minutes duration, followed by the 'CPT Instructions':

"We are now going to test your ability to cope with prolonged pain. You will be asked to insert your left hand to a bucket full with ice water. You have to keep your hand in the water

until we tell you. (No Information)
for 4 minutes. (Exact Information)
for 5 minutes. (False Long)
for 3 minutes. (False Short)

If you are able to finish the task, you will receive IS10.00 in addition to your previous earnings. START!"

After 2 minutes and 45 seconds, subjects in the last two groups were given the correction: "Pay attention! The time was shortened from 5 to 4 minutes. (False Long)
prolonged from 3 to 4 minutes. (False Short)
All other conditions remain the same."

Following the termination of CPT (either by the subject or after 4 minutes), the 'Final Relaxation' Instructions were given:

"Now try to relax for a few minutes."

This took 2 minutes, after which time one of the experimenters entered the subject's room, removed the heart-rate electrode, and presented the subject with the Post Experimental Questionnaire. (See Appendix B). The personality test were then given in the following order: Beck, Rotter, Denial. The subject was given his remuneration, thanked for his participation, and reminded of his promise not to discuss the experiment with anybody.

RESULTS AND DISCUSSION

The total sample consisted of 80 male subjects that were randomly allocated to the four experimental groups. Due to some technical difficulties, such as occasional noise in the recording of heart-rate, not all subjects produced the entire spectrum of data collected.

Effectiveness of the stressors.

The first analysis tested two important issues at the same time: the fairness of the allocation procedure, and

the validity of the stress manipulation. This was accomplished by comparing the heart-rate between groups during the last 30 seconds of the pre-stress relaxation, and during the first 30 seconds of stress. This was done twice, for each stressor separately. A Repeated Measures Manova was carried out. Table 2 presents the results for the first stressors, i.e. the dynamometer.

Insert Table 2 about here

The analysis indicates that there are no significant Group effects either before the stressor, or during stress onset. The random allocation to the different groups was, therefore, fair.

More important, however, are the dramatic changes in heart-rate as a consequence of the dynamometer task. Whereas the pre-stress mean for the entire sample was 76.8 beats per minute, the stressor raised this to the mean level of 110.2. Moreover, the comparisons of the respective means for each of the groups separately, suggests that the size of this effect is highly reliable.

The results for the CPT appear in Table 3.

Insert Table 3 about here

Table 3 presents essentially the same picture. Once again, there are no significant Group effects, whereas the impact of the stressor on heart-rate is highly significant. The pre-stressor mean for the entire sample was 78.8 beats per minute, which the stressor raised to 95.3. The within groups comparisons are highly consistent. Comparing the impact of the two stressors, it is obvious that the dynamometer task has a greater impact on heart-rate than the cold pressor task. This is consistent with the different nature of these two stressors: whereas the dynamometer requires expenditure of effort, the CPT is essentially a passive task.

From the point of view of this research, the central aspect of the above results, is the clear indication that on the psychophysiological level, both tasks are highly stressful. In order to complete the picture, the subjective appraisal of the stressors was measured by the two relevant post-experimental questions (Question 2, and Question 9).

On a five-point scale of subjective difficulty ranging from 1 (Extremely Difficult) through 5 (Not Difficult), the mean level of difficulty for the two stressors were 2.49 and

2.68 respectively, i.e. between Difficult and Intermediately Difficult.

Effect of Information/No Information on endurance.

The central hypothesis of this research is that absence of information concerning the duration of a stressful task increases the deleterious effects of stress, and reduces its endurance. Our study makes it possible to test this hypothesis utilizing the obviously valid criterion of task completion. This is done by comparing the first two groups, i.e., the No Information group (Group 1) with the Exact Information group (Group 2).

Starting with the Dynamometer task, in Group 1, 31.6% of subjects were able to successfully complete the task, as compared with 76.5% in Group 2! The analysis of variance yields $F(1,36)=8.581$, which is significant ($P<.01$).

Moving now to the Cold Pressor Test, in the No Information condition 30% of subjects were able to keep their hand in the ice water for the entire 4 minutes, whereas in the Exact Information group there were 60% that endured the stressful task to the end! The Anova showed $F(1,38)=3.8$ ($P=.05$). While the relatively small number of subjects used, necessarily reduced the significance level of these results, the chances of endurance until completion is doubled by procuring exact information about the duration of the task!

And what about those subjects who were unable to finish the tasks given to them? Starting with the dynamometer task, we find that if subjects were unable to go all the 70 seconds, there were no major differences between the two groups. Thus, in the No Information group the mean duration was 43.6 seconds, whereas in the Exact Information group it was 50 seconds. Moving now to the CPT, the means are 67.3 and 67.8 seconds respectively. This negligible advantage of information is not significant, and suggests that there may be a qualitative difference between finishing the task and the duration of perseverance without finishing it. When there is a clear goal to be achieved, it is conceivable that the main difference is between conditions which facilitate the achievement of that goal and those that are detrimental to its completion. If the goal is not attained, it is, perhaps, of lesser import how long a person kept up the activity before breaking down under the strain.

In order to further validate the impact of information, it was assumed that subjects who are aware of the fact that they are at the very end of their ordeal, should exhibit higher levels of arousal than those without any such information. Thus, the heart-rate at five seconds before termination of the task, and heart-rate exactly at termination of the task were computed for both groups. It

should be noted that these groups included both those subjects that finished the task successfully, and those that terminated it before successful completion.

Starting with the dynamometer task, the mean heart-rate five seconds before the end for the No Information group was 99.8 whereas for the Exact Information group it was 118.1. This difference which is statistically significant ($F=4.76$, $P<.05$), clearly indicates the impact of information on arousal, as measured by the heart-rate channel. The picture is essentially the same looking at the heart-rate at termination itself. The means are 99.3 and 107.2, respectively.

Moving now to the CPT, there were similar indications, but not statistically significant. This again suggests the psychophysiological differences between the two tasks. Whereas the dynamometer requires the expenditure of energy, the CPT is essentially a passive task.

Effects of information change

Our design allows us to test the potential impact of information change during the stressful tasks themselves. Whereas one of the groups started with essentially discouraging information with subsequent encouraging correction (Group 3), the other one (Group 4) received an exactly opposite treatment, i.e., encouraging information at start, with discouraging correction later.

Our first analysis is concerned with the chances of successful completion of the two tasks in these different groups. Results indicate that there are no significant differences between these two groups in neither of the tasks. Furthermore, their rate of success falls halfway between the No Information and the Exact Information groups (Group 3 had 65% success with the first task as compared with 50% for Group 4). In the CPT the numbers are 53% and 56% respectively.

The fact that successful completion rates fall in between the two extreme groups of No Information and Exact Information, makes, of course, psychological sense. Whatever the psychological disadvantage of Group 3 at start, is subsequently alleviated when the subjects hear the good news about the duration of the task. In the same vein, the initial psychological advantage of Group 4 is lost when the disenchanting correction arrives. At the same time, however, the advantages and disadvantages, while cancelling each other, do not do so entirely. The detrimental effects of the disadvantages appear to be more potent than the beneficial effects of the advantages, leading to a net result which is below the success rate of the Exact Information condition. Due to the paucity of experimental evidence at this stage of our enquiry, this conclusion is necessarily a tentative one. Further research, as planned

in our experimental program, can throw additional light on this important issue.

The impact of the change on heart-rate, while visible, is not a significant one. The analysis was done only on those subjects who persevered in the tasks up to the point of the announced change in duration. After selecting those subjects, for every subject, the change in heart-rate before and after the new information was computed. On DT, Group 3 had a net decrease of 5.0 beats per minute, and Group 4 a decrease of 3.1. On CPT, the mean changes were .6 and -3.0 respectively, the latter indicating that in Group 4 the information increased, rather than decreased the heart-rate. This effect, while in the predicted direction, did not reach statistical significance.

In order to test once again, now in a larger context of data, the impact of information vs. no information on subjects' heart-rate during the last phase of stress, two ANOVAs between groups were performed: The first consisted of heart-rate during the last 30 seconds prior to stress termination, and the second of heart-rate just 5 seconds before end. The results for DT, according to groups were: No Information 88.0, Exact Information 121.8, Group 3 113.9, and Group 4 107.4. These differences were found to be statistically significant ($F=4.82$; $P<.01$), primarily because of the large difference between the No Information condition, and all the others. Clearly, in the absence of explicit information about task termination heart-rate does not reach the dramatic highs exhibited in situations which employ clock. Looking at the last 5 seconds only, the results are very much the same. As before, however, in CPT, there is no clear indication of this phenomenon.

Relationships between the two stressful tasks.

The active nature of DT as compared to the more passive CPT has been already mentioned. This essential discrepancy between the two tasks further justifies their joint usage; since they present different challenges, they also measure different aspects of our research problem. It is thus of particular interest to test the extent to which successful completion of one task predicts the successful completion of the other one. The distribution of subjects who completed (+) or failed to complete (-) the two stressful tasks appears in Table 4.

Insert Table 4 about here

Table 4 clearly indicates that there is a strong positive relationship between the success/failure of both tasks. (CHI SQUARE=16.05, 1 d.f., $P<.01$). 74% of subjects

either succeeded, or failed on both. This high level of congruence can result from inter-task similarity, from stable personality differences, or some combination of both. It should be noted, however, that the particular design used in this study, namely replicating the same information condition in both tasks, necessarily increases the psychological overlap between the two tasks.

Information from the post-experimental questionnaire suggests that whereas the subjective rating of difficulty of each of the tasks are quite similar, when asked to compare them directly, most subjects (74%) report DT as being more stressful than CPT. Moreover, the result of this comparison is related to successful completion of CPT. Thus, subjects who reported DT as being more stressful, had better chance of completing CPT than those that reported CPT as the more difficult of the two (56% and 23% respectively, $F=5.69$, $P<.05$). A word of caution is, however, necessary. Since at the time of filling the post-experimental questionnaire subjects were already aware of their performance on the two tasks, this obviously influences the status of the above finding. At the same time, it is interesting that this logical relationship between subjective report of difficulty on the one hand, and behavioral endurance on the other hand, was found to relate only to CPT. It is conceivable that the longer duration and the passive nature of this task, makes it more sensitive to effects of cognitive appraisal.

When endurance breaks down: Search for indicators

There is no need to dwell upon the practical importance of having access to signs which precede the point when a person's endurance breaks down. The variety of potential uses of such information encompasses both corrective and preventive measures. Not less important, however, are the potential theoretical payoffs of such indicators. By providing a better clue to our understanding of endurance on the one hand, and the transition from effective performance to the point of breaking down under the strain, such understanding opens a whole variety of new, potentially very important issues.

The subjects in this study fall basically into two categories: those that were capable of successfully carrying out both of the stressful tasks to their completion, and those who could not accomplish either one or both of the given goals. It is of potentially great benefit to search our data for some hints which may indicate the proximity of a crisis. Whereas a crisis need not invariably lead to a person's giving up, there certainly is a possibility for such a relationship.

In order to search for such clues, we located in each segment of the experiment the exact time when subjects' heart-rate was at its peak, or maximum. The mean timing of

maximal heart-rate for the CPT according to groups were: Group 1, 67.2 seconds, Group 2, 42.4 seconds, Group 3, 29.8 seconds, and Group 4, 62.8 seconds after the start.

Group 1, i.e. the No Information condition, is a special case, since subjects have no idea about the expected duration of the stress. Thus, for them, the crisis can actually signal the breaking point of endurance. Computing the average timing of CPT for those subjects who did not finish the task, we find that it was 67.3 seconds after its onset. This corresponds almost exactly to the timing of the maximal heart-rate in this group! This finding raises the possibility that in the absence of information about duration of a stressful task, the maximal heart-rate can be a potentially useful predictor of breakdown.

Looking at the results of the remaining three groups, we can observe a highly systematic pattern: Group 3, which anticipates a five minute duration of CPT reaches the maximum first, then comes Group 2, which anticipates four minutes, and finally Group 4, which believes that the task will last three minutes only. In other words, the longer the anticipated duration of the stressful task, the sooner the maximal heart-rate. Such a clear relationship between the two adds some validity to the notion that maximal heart-rate is associated with a crisis.

We have here a clear indication of the psychological aspects of such a crisis. The physiological stressor of the cold water is, after all, similar for all three groups; the difference between them is entirely in the domain of information and anticipation. It follows, that such information can control to some extent the onset of the crisis itself. Needless to say, this finding ought to be tested further using other information conditions, as well as replicated using similar conditions. It is simply too important to be left as is.

When a person has information about the anticipated duration of a stressful task, and when he has access to a timing device which gives him ongoing feedback about distance from goal, a crisis need not imply breakdown. On the contrary, it is quite conceivable that the person distributes his or her energy according to the anticipated duration ahead of him or her. Common wisdom often quotes soldiers or athletes claiming that once they passed a critical point, the rest was much easier for them. It is, therefore, possible that one of the main advantages of information is precisely that, namely, that it allows a person to somehow plan the distribution of effort.

It warrants mentioning that in the clock condition, 74% of all subjects who could not finish the CPT gave up before the end of the first minute. Once past the first minute there was a fair chance of completing the task. This suggests that subjects used in some psychological sense the

yardstick of the full minute as a criterion for their subjective evaluation of their chances to succeed in the task. The finding that there was nothing specific about one minute in Group 1 indicates that it is not due to some physical or physiological consequences associated with one minute, but rather a psychological process. One possible speculation is that around that time subjects were able to make a final internal commitment to try and finish the task. Such a commitment, could make it easier for them psychologically, as well as perhaps release some substances s' ch as endorphins and actually reduce the pain experienced. Although we have at this time no direct evidence of this process taking place, after the experiment several subjects mentioned spontaneously that they didn't know at first whether they have a chance to finish the task, and only after one minute decided to give it a fair try.

The above argument received additional confirmation by analyzing the possible relationship between timing of maximal heart-rate and success on the CPT. The mean timing of maximal heart-rate of subjects failing the task was 33.5, whereas those who completed the entire 4 minutes reached the maximal heart-rate at 75.2 seconds. Analysis of Variance was performed on these results, yielding $F=7.43$, $P<.01$. Since this data is based only on subjects who are still potentially capable of finishing the task, it cannot be seen as an artifact. This finding significantly increases the possibility that maximal heart-rate reflects processes that are related to the chances of success or failure on a stressful task.

In addition to the timing of the maximal heart-rate, we can compare the actual maximal rates of those who completed the task with those who failed to reach completion. The means were 120.5 and 106.0 respectfully ($P<.05$). This indicates that subjects who eventually completed the task reacted with higher heart-rate elevation during their maximal arousal than those who failed the CPT. It is important to note that high psychophysiological arousal in itself is not necessarily a negative sign. On the contrary, it may indicate the ability to mobilize greater resources when they are needed most (e.g., during a critical phase). The intensity of the reaction has, therefore, an entirely different implication than its timing.

Individual differences in endurance.

Our research program envisages the analysis of individual differences at a more advanced stage of our enquiry. The main reason for this postponement is, of course, the need to have a more extensive data base, both in terms of a more thorough understanding of the importance main effects, and in terms of having access to a larger pool of subjects.

Our initial results are quite promising. Thus, there is a significant negative correlation between DENIAL and performance on CPT ($r=-.21$, $P<.05$). This is in line with our main finding concerning the advantage of exact information. This preliminary finding raises the possibility that in addition to externally induced information which may or may not be veridical, there is a corresponding internally induced information that may play a similar role. For instance, subjects high on Denial, may view a given stressful task as a False Short one, only to be disappointed later.

The initial results also point to some relationship between External Locus of Control and higher success rate on both DT and CPT. If corroborated by further research, this finding may lead us to a better understanding of those persons who perform better when they depend entirely on external sources. This variable may interact in an interesting fashion with the types of effects of external information that are the focus of our research.

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Table 1: The Experimental Design.

Group No.	Information Condition	Dynamometer	CPT
1	No Information	+	+
2	Exact Information	+	+
3	False Long	+	+
4	False Short	+	+

Table 2: Impact of Dynamometer on Heart-rate, by Group.

Group	Before Stress Mean	Before Stress Stand. Dev.	Stress Onset Mean	Stress Onset Stand. Dev.
1	77.2	13.5	108.4	15.8
2	75.4	12.7	114.9	13.5
3	78.8	11.9	108.6	15.0
4	75.8	11.0	108.5	14.3

Tests of Significance for Before Stress:

Source	SS	DF	MS	F	SIGN.
Within	15760.9	58	271.74		
Constant	1069585.1	1	1069585.10	3936.04	<.00
Group	153.0	3	50.99	.19	NS

Tests involving Stress Onset within-subject effect:

Source	SS	DF	MS	F	SIGN
Within	5613.9	58	96.79		
Stress	33957.2	1	33957.23	350.83	<.00
Group by Stress	461.74	3	153.91	1.59	NS

Table 3: Impact of CPT on Heart-rate by Group.

Group	Before Stress Mean	Before Stress Stand. Dev.	Stress Onset Mean	Stress Onset Stand. Dev.
1	78.7	14.8	93.4	14.0
2	78.5	15.9	97.3	19.3
3	81.5	11.0	95.7	13.0
4	76.2	10.0	94.3	11.3

Tests of Significance for Before Stress:

Source	SS	DF	MS	F	SIGN
Within	21035.5	57	369.04		
Constant	913081.5	1	913081.50	2474.18	<.00
Group	218.6	3	72.85	.20	NS

Tests involving Stress Onset Within-subject effect:

Source	SS	DF	MS	F	SIGN
Within	1859.1	57	32.62		
Stress	8181.6	1	8181.59	250.85	<.00
Group by Stress	127.5	3	42.49	1.30	NS

Table 4: Success or Failure on DT and CPT.

		CPT +	CPT -	Total
DT	+	27	11	38
	-	7	24	31
	Total	34	35	69

Appendix A: Denial Questionnaire.

The likelihood (chances) for the entire population	The likelihood (chances) that it will happen to you (mark any number between 0 and 100%)
1. The likelihood of being involved in a car accident on a specific road is 10%.	
2. The likelihood of being electrocuted while fixing part of the electric system is 20%.	
3. The likelihhod of succeeding in a test in school is 70%.	
4. The likelihood of complete recovery after major surgery is 40%.	
5. The likelihood of getting jaundice during a jaundice epidemic is 50%.	
6. The likelihood of getting hurt during a plane crash is 95%.	
7. The likelihood of going broke because of a business deal is 30%.	
8. The likelihood of drowning while swimming in a very stormy sea is 60%.	
9. The likelihood of being caught by the police while speeding is 20%.	
10. The likelihood that a child will be born with a defect is 10%.	
11. The likelihood of being gossipped about during a social gathering is 50%.	
12. The likelihood of being reprimanded by the commander/boss while carrying out a task is 80%.	
13. The likelihood of getting hurt while skydiving is 10%.	

14. The likelihood of becoming insane after two years as a prisoner of war is 60%.

15. The likelihood of experiencing an earthquake is 5%.

16. The likelihood of collapsing during an arduous military march is 20%.

17. The likelihood that there will be a misfortune in a family within the next year is 10%.

18. The likelihood of failing the first driving test on a tractor is 40%.

19. The likelihood of getting caught in a terrorist attack is 30%.

20. The likelihood of falling asleep during guard duty after a day of arduous training is 40%.

21. The likelihood of getting hit in a tornado is 5%.

22. The likelihood of being hit by some object falling from the sky is 1%.

23. The likelihood of working at some uninteresting, unsatisfactory civilian job within the next few years is 30%.

24. The likelihood of spraining one's foot while ice-skating is 5%.

Appendix B: Post-experimental Questionnaire.

1. Estimate how long you held your hand in the ice water._____
2. Estimate the difficulty you had in keeping your hand in the ice water (Circle the appropriate answer):
   a. Very difficult
   b. Difficult
   c. Fairly difficult
   d. Hardly difficult
   e. Not at all difficult
3. Try to describe (by drawing) the difficulty you had in keepeing your hand in the ice water, throughout the experiment, along the following continuum: How did you feel at the beginning, shortly after the beginning, in the middle, towards the end, and at the end.

very difficult

difficult

fairly difficult

hardly difficult

not at all difficult

at the beginning	shortly after the beginning	in the middle	towards the end	at the end

4. Did you take any measures in order to alleviate the pain?_____
If yes, describe:_____
_____
5. When you decided to remove your hand from the water, was your decision a sudden one or a gradual one preceded by indecision?_____
How long do you think the indecision lasted?_____
6. Try to describe briefly your thoughts - why did you keep your hand in the water?_____
_____
7. Imagine that you are in the middle of the experiment, with your hand in the water, and complete the following sentence:
To keep your hand in the water would be_____
_____
8. Try to estimate the length of time that you pressed the dynamometer _____ minutes.

9. Estimate the difficulty you experienced in pressing the dynamometer (Circle the appropriate answer):
   a. Very difficult
   b. Difficult
   c. Fairly difficult
   d. Hardly difficult
   e. No difficulty

10. Which of the two tasks was more difficult? Explain _____

_____

11. Did you use any measures in order to continue pressing the dynamometer? Describe:_____

12. When you decided to release the lever was your decision a sudden one or a gradual one preceded by indecision? How long do you think the indecision lasted?_____

_____

13. Try to describe your feelings when you were notified of the change in duration:
While pressing the dynamometer: _____

_____

While your hand was in the ice water:_____

_____

14. How did the fact that the duration of pressing the lever was changed affect your expectations about the time your hand had to be in the ice water?_____

_____

15. Try to describe (by drawing) the difficulty you experienced in keeping your hand in the ice water throughout the experiment along the following continuum: How did you feel at the beginning, shortly after the beginning, when you were notified of the change in duration, towards the end, and at the end.

very difficult
difficult
fairly difficult
hardly difficult
not at all difficult

at the beginning	shortly after the beginning	upon notification	towards the end	at the end